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TRENDS IN CONSUMPTION AND PRICES OF CHEMICAL RAW MATERIALS AND FERTILIZERS

BY

OLIVER BOWLES AND ETHEL M. TUCKER

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

TRENDS IN CONSUMPTION AND PRICES OF CHEMICAL RAW MATERIALS AND FERTILIZERS[1]

By Oliver Bowles[2] and Ethel M. Tucker[3]

CONTENTS

	Page
ntroduction	1
rowth of the chemical process industries	2
onmetallic minerals used in chemical process industries	3
ertilizer materials	3
ndividual commodities	4
Sulfur and pyrite	4
Salt	5
Chemical and industrial lime	9
Chemical limestone	10
Metallurgical limestone (flux)	12
Fluorspar	12
Barite	14
Boron minerals	17
Potash	19
Phosphate rock	21
Nitrogen	21
Agricultural liming materials	24

INTRODUCTION

In 1943 the Bureau of Mines began a review of trends in consumption and rices of the more important nonmetallic minerals. The first report covering uilding materials[4] appeared in December of that year. The present paper, hich deals with chemical raw materials and fertilizers, is the second of the eries.

The 34 years from 1910 to 1943, for which statistics are presented herein, omprise periods of uneventful peace, unparalleled prosperity, industrial depression almost to the point of stagnation, and two wars of world proportions.

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[1] The Bureau of Mines will welcome reprinting this paper provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7320."

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[4] Bowles, Oliver and Jensen, Nan C. Trends in Consumption and Prices of Building Materials: Bureau of Mines Inf. Circ. 7265, 1943, 24 pp.

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The purpose of this report is to trace the consumption and price history of the chemical and fertilizer raw materials industries as affected by the violent fluctuations in industrial activity throughout these eventful years. The reactions of industry and agriculture to changing circumstances are worthy of careful consideration because the history of the past may serve as a guide to the future. Such studies are of particular interest at this time when plans for post-war adjustments are demanding the most thorough evaluation of all factors involved.

The chemical industries depend upon minerals for a substantial part of their essential raw materials. Sulfur, salt, and lime are outstanding examples of well-known mineral substances employed in enormous quantities either as active reagents or as components of finished products. Chemical processes form the backbone of industrialism. In no nation or community can diversified manufacturing and processing industries become dominant unless chemical raw materials are available in adequate quantities at moderate prices. The United States has been richly endowed with most of these essential commodities, and their abundance and availability have been decisive factors in the enormous growth of the chemical industries that has marked the past 30 years.

GROWTH OF THE CHEMICAL PROCESS INDUSTRIES

It is difficult to measure the output of the chemical process industries because some doubt exists as to just what industries should be included. Many industries not classed strictly as chemical employ chemical processes. Chemical and Metallurgical Engineering[5/] has presented a table based on Bureau of the Census figures for the value of output of the chemical processing industries for selected years from 1899 to 1937. These data, with the addition of figures for 1939, appear in table 1. Figures for years later than 1939 are unavailable.

TABLE 1. - Value of output, chemical process industries, 1899-1939

Census year	Total value of chemical production	Total value of all manufactures	Percent of total
1899	$2,105,278,610	$11,406,926,701	18.5
1904	2,853,889,346	14,793,902,563	19.2
1909	3,939,565,626	20,672,051,870	19.0
1914	4,803,776,616	24,214,515,000	19.8
1919	12,219,536,700	62,193,427,000	19.7
1921	8,533,839,320	43,653,283,000	19.6
1923	11,732,249,757	60,555,998,000	19.3
1925	11,511,277,000	62,668,260,000	18.4
1927	11,728,242,247	62,718,347,289	18.7
1929	11,966,714,000	70,434,863,443	17.0
1931	8,104,569,000	41,521,147,127	19.5
1933	6,594,876,481	31,400,000,000	21.0
1935	8,478,402,000	44,993,699,000	18.8
1937	11,228,433,000	60,710,073,000	18.5
1939	11,102,398,495	56,935,000,000	19.5

5/ Chem. and Met. Eng., September 1939, p. 543.

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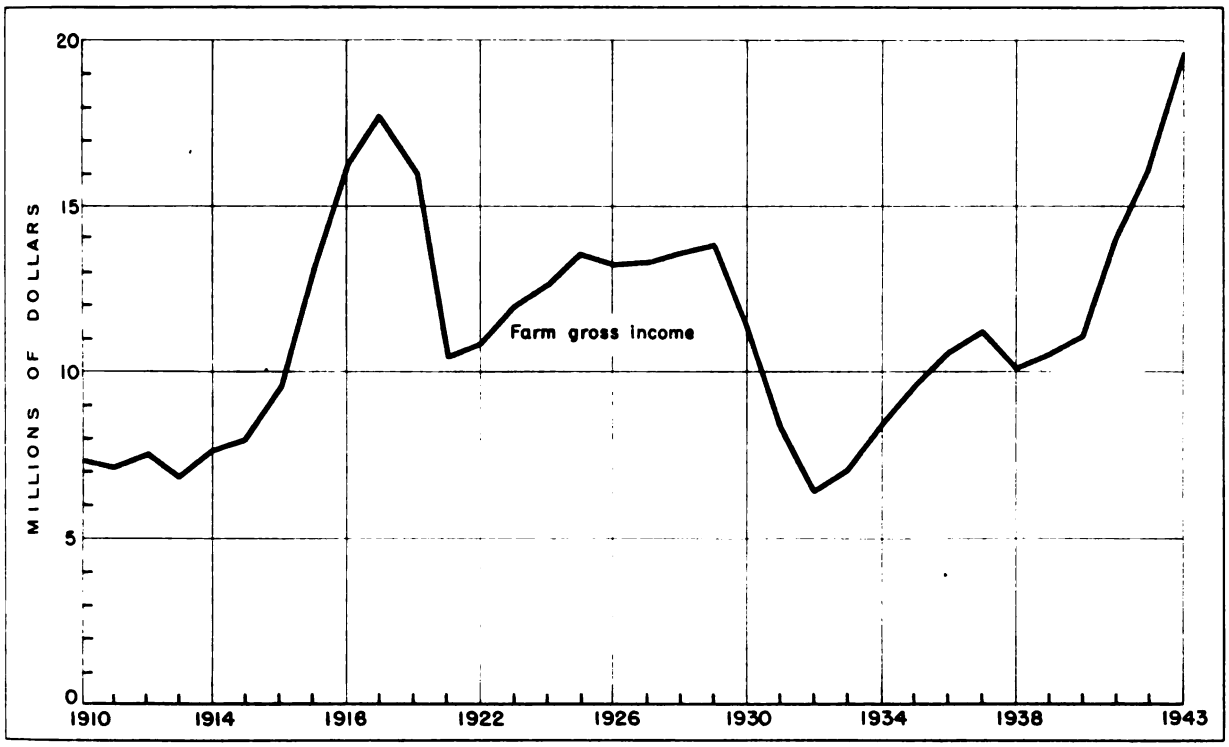

FIGURE 1.- Farm gross income in the United States, 1910-43.

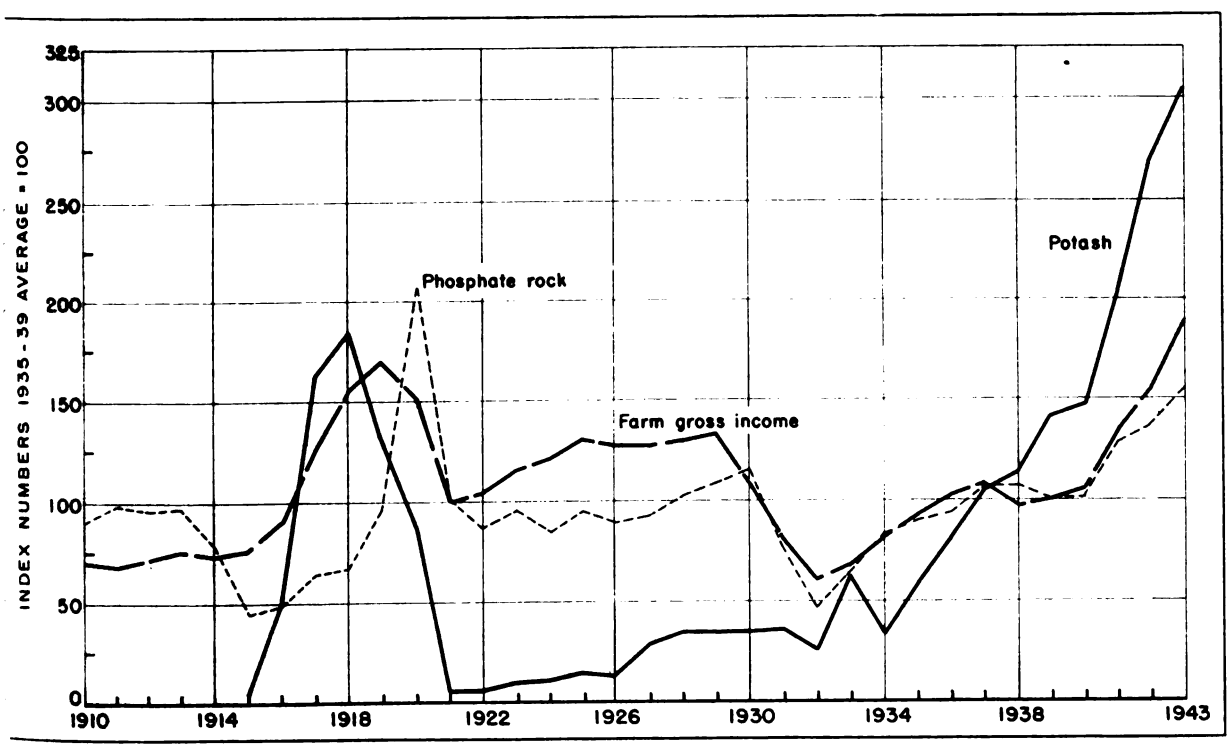

FIGURE 2.- Trends in production of phosphate rock and potash in the United States compared with farm gross income, 1910-43.

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The industries covered are as follows: Chemicals; Coke-oven Products; rugs and Medicines; Perfumes, Cosmetics and Toilet Preparations; Distilled iquors; Explosives and Fireworks; Fertilizers; Glass, Clay Products and Re-ractories, Pottery Porcelain, and Sand Lime Brick; Leather Tanning; Lime nd Cement; Oils and Fats (Cottenseed, Linseed and Essential Oils and Greases); aints, Pigments, Varnishes, and Lacquers; Paper and Pulp; Petroleum Products; ayon and Allied Products; Rubber Goods (tires, tubes, boots, shoes, etc.); oap and Cleaning and Polishing Compounds; Beet and Cane Sugar Refining; and iscellaneous Products as follows: Coated Fabrics; Blacking, Stains and ressings; Blueing; Bone Black, Carbon Black and Lamp Black; Candles; Manu-actured Fuels; Glue and Gelatine; Graphite, Gypsum; Printing and Writing nks; Linoleum and Asphalt-Felt Base Floor Coverings; Matches; Ground and reated Minerals and Earths; Mucilage, Paste and other Adhesives; Photographic aterials; Paving Materials (other than brick and stone); Prepared Roofing; allboard and Building Insulation; and Wood Preserving.

As indicated in the table, the chemical process industries were rela-ively small early in the period under consideration. Their total value of utput in 1914 was about 4 billion 800 million dollars. The urgent need of hemical products during the First World War pushed production to a maximum or that period of more than 12 billion dollars in 1919. The decisive drop n 1921 was due in part to the collapse of inflationary prices. The high evel of the prosperous years 1923 to 1929 was followed by the precipitous rop of the depression period. During these years, as in 1921, lower price evels accentuated the decline. The chemical process industries staged a trong recovery from 1935 up to the Second World War, the needs of which have timulated production far beyond all previous records. Value of output may ave reached or even exceeded 15 billion dollars in 1944.

NONMETALLIC MINERALS USED IN CHEMICAL PROCESS INDUSTRIES

The principal nonmetallic minerals required by the chemical processing ndustries are sulfur and pyrite, salt, chemical lime and limestone, fluorspar, arite and boron minerals. Sodium carbonate, sodium sulfate and calcium-mag-esium chloride which are also important chemical raw materials, occur in ature, but by far the larger proportions of such salts consumed are products f other chemical industries, chiefly those using sodium chloride (common alt) as raw material. Accordingly they are not considered in this report hich is confined to natural minerals and rocks.

FERTILIZER MATERIALS

Consumption of fertilizers is governed largely by the buying power of armers, and this in turn depends primarily on farm gross income. As indi-ated in figure 1, compiled from Statistical Abstracts of the United States, ars have a decidedly stimulating effect on farm income. Although the weapons nd tactics of war may undergo fundamental changes, armies, as well as navies nd air forces, still, figuratively, travel on their stomachs. The war peaks hown in the figure are of course overemphasized to some extent by the bnormally high prices which are inevitable accompaniments of war.

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The principal mineral-fertilizer raw materials are potash, phosphate rock, nitrates, agricultural lime, and agricultural limestone. Nitrates occupy a somewhat unique position in that deposits of natural nitrogen com pounds are insignificant in the United States and that domestic requiremen obtained in early years chiefly from Chile were later manufactured from synthetic nitrogen obtained from the air - an inexhaustible resource.

Figure 2 traces the value of production of potash and phosphate rock compared with gross farm income from 1910 to 1943. The units employed are percentages of the 1935-39 average.

The potash peak of 1918 was due to the extraordinarily high prices oc sioned by the extreme scarcity of the commodity at that time, but the peak 1943 reflects the rapid growth of domestic production which became great enough to satisfy all domestic needs. The phosphate rock peak of 1920 was due partly to the large tonnage sold, and partly to the abnormally high prices that prevailed. Phosphate rock sales values have followed the tren of farm income rather closely since 1930. The domestic potash industry, however, has been controlled largely by factors quite independent of farm income throughout its entire history, although the buying power of farmers has influenced its growth to some extent since 1932.

INDIVIDUAL COMMODITIES

The various chemical and fertilizer raw materials of mineral origin a considered individually in following pages, with tables of production, con sumption, and prices since 1910. Unfortunately for some of the commoditie in which foreign trade is an important element, data on consumption cannot be given for years later than 1941 because publication of foreign trade fi ures is restricted for reasons of security. In a few instances statistica data were unavailable as far back as 1910.

Sulfur and Pyrite

Consumption. - The principal use of sulfur and pyrite is for manufact of sulfuric acid, which has been designated "the old warhorse" of chemical manufacture. More than 13,900,000 short tons of sulfuric acid were consum in the United States in 1943. It is used primarily as a reagent in the fe lizer, petroleum-refining, and a host of other chemical and processing ind tries. Over three-fourths of all sulfur and an even higher proportion of pyrite is converted into sulfuric acid. All but a very small part of sulf and pyrite consumption is therefore employed in industries which, under th somewhat broad classification recognized herein, are classed as chemical industries.

Until shortly before the turn of the century the sulfuric acid indust depended primarily on Sicilian sulfur, but later pyrite dominated the mark Development of the vast sulfur deposits of the Gulf coast, after invention the Frasch process for mining it in a molten condition, enabled sulfur to gain the lead by the time of the First World War; nevertheless, pyrite has continued to be an important source of sulfur also. From 1922 to 1930 the

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ulfur content of pyrite constituted 14 to 20 percent of the total sulfur consumed in the United States. From 1931 to 1940 the sulfur content of the pyrite consumed was 20 to 28 percent of the total; but thereafter, because of wartime construction of new plants designed to use native sulfur only, the proportion has been much smaller.

Total sulfur consumption follows in general the trends of industrial activity and therefore fluctuates widely with booms and depressions. Its use in explosives and many heavy chemical industries promotes substantial growth in war periods as indicated in tables 2 and 3. The tremendous industrialization of the United States during the past 30 years is reflected in the striking increase in total consumption of sulfur, which in 1941 was more than four times as great as in 1911. There are no substitutes for sulfur for its major uses, therefore a steady and substantial market may be expected for it, although the proportion obtained from brimstone or from pyrite may fluctuate under changing circumstances.

Prices. - As indicated in table 2, sulfur prices have remained remarkably constant. From 1939 to 1941 they averaged about 10 percent lower than from 1910 to 1914. Pyrite prices (table 3) have been much lower during recent years than they were 30 years ago.

Salt

Consumption. - Salt consumption from 1910 to 1914, as indicated in table 4, ranged from 4,300,000 to 4,900,000 tons a year, but as World War I developed it increased substantially and by 1918 had reached more than 000,000 tons a year. Thereafter it ranged generally from 6,000,000 to 000,000 tons until 1940 when, under the impact of growing demands for many emical products to supply war needs, it increased greatly, attaining a cord of over 15,000,000 tons in 1943.

Salt is a very important chemical raw material, particularly for the nufacture of such alkalies as soda ash, bicarbonate of soda, and caustic da. It is also used for making a great variety of sodium salts, such as e acetate, benzoate, chromate and bichromate, bromide, chlorate, citrate, d many others. The chemical compounds of sodium are used in a multitude manufacturing industries.

There is no definite statistical break-down of salt used as a chemical w material. Salt in brine is so used almost exclusively, but thousands of ns of dry salt are also employed for chemical purposes. Phalen[6/] states at in 1933 the chemical industries, primarily soda alkali manufacture, used percent of the entire production in the United States. As salt in brine the principal source of salt used for chemical purposes it is interesting trace the trend in salt in brine output compared with total salt production. r 5-year periods beginning with 1919, the proportion of salt in brine to tal salt shows a steady increase as follows: 1919-23, 38 percent; 1924-28, percent; 1929-33, 45 percent; 1934-38, 48 percent; and 1939-43, 53 percent. is indicates that the chemical uses of salt have been growing more rapidly an the other uses.

6/ Phalen, W. C., Industrial Minerals and Rocks: 1937, p. 668.

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TABLE 2. - Sulfur

Year	Domestic production				Net exports (long tons)	Apparent consumption	
		Value					
	Long tons	Total	Average per ton[1/]	Price index nos. 1935-39, ave. = 100		Long tons	Index nos. 1935-39, ave. = 100
1910	250,919	$4,522,000	$18.02	104	2,086	248,833	18
1911	253,795	4,573,000	18.02	104	3,903	249,892	18
1912	305,390	5,289,000	17.32	100	30,851	274,539	19
1913	319,333	5,617,000	17.59	102	74,099	245,234	17
1914	341,985	6,214,000	18.17	105	74,553	267,432	19
1915	293,803	4,959,000	16.88	97	12,665	281,138	20
1916	766,835	12,246,000	15.97	92	107,466	659,369	46
1917	1,120,378	23,987,000	21.41	124	151,763	968,615	68
1918	1,266,709	27,868,000	22.00	127	131,037	1,135,672	80
1919	678,257	10,252,000	15.12	87	224,635	453,622	32
1920	1,517,625	30,000,000	19.77	114	477,406	1,040,219	73
1921	954,344	17,000,000	17.81	103	285,758	668,586	47
1922	1,343,624	22,000,000	16.37	95	485,497	858,127	60
1923	1,618,841	26,000,000	16.06	93	472,060	1,146,781	81
1924	1,537,345	25,000,000	16.26	94	481,109	1,056,236	74
1925	1,858,003	29,000,000	15.61	90	629,301	1,228,702	86
1926	2,072,657	37,300,000	18.00	104	576,918	1,495,739	105
1927	2,072,109	38,300,000	18.48	107	785,890	1,286,219	91
1928	2,082,924	37,500,000	18.00	104	680,264	1,402,660	99
1929	2,437,238	43,800,000	17.97	104	854,020	1,583,218	112
1930	1,989,917	35,800,000	17.99	104	593,283	1,396,634	98
1931	1,376,526	24,800,000	18.02	104	407,586	968,940	68
1932	1,108,852	20,000,000	18.04	104	352,610	756,242	53
1933	1,637,368	29,500,000	18.02	104	517,742	1,119,626	79
1934	1,613,838	28,900,000	17.91	103	501,276	1,112,562	78
1935	1,634,990	29,300,000	17.92	103	400,620	1,234,370	87
1936	1,968,820	35,400,000	17.98	104	546,669	1,422,151	100
1937	2,466,512	44,300,000	17.96	104	674,899	1,791,613	126
1938	1,628,847	27,300,000	16.76	97	579,056	1,049,791	74
1939	2,233,817	35,500,000	15.89	92	627,784	1,606,033	113

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Year	Domestic production				Net imports (long tons)	Apparent consumption	
		Value					
	Long tons	Total	Average per ton	Price index nos. 1935-39, ave. = 100		Long tons	Index nos. 1935-39, ave. = 100
1910	241,612	$977,978	$4.05	133	803,551	1,045,163	107
1911	301,458	1,164,871	3.86	127	1,006,310	1,307,768	134
1912	350,928	1,334,259	3.80	125	970,785	1,321,713	135
1913	341,338	1,286,084	3.77	124	850,592	1,191,930	122
1914	336,662	1,283,346	3.81	125	1,026,617	1,363,279	140
1915	394,124	1,674,933	4.25	139	964,634	1,358,758	139
1916	439,132	2,038,002	4.64	152	1,244,662	1,683,794	173
1917	482,662	2,593,035	5.37	176	967,340	1,450,002	149
1918	464,494	2,644,515	5.69	187	496,792	961,286	98
1919	420,647	2,558,172	6.08	199	388,973	809,620	83
1920	310,777	1,596,961	5.14	169	332,606	643,383	66
1921	157,118	711,432	4.53	149	216,229	373,347	38
1922	169,043	671,241	3.97	130	279,445	448,488	46
1923	181,628	661,000	3.64	119	263,695	445,323	46
1924	160,096	645,262	4.03	132	246,737	406,833	42
1925	170,081	650,448	3.82	125	276,385	446,466	46
1926	166,559	616,668	3.70	121	366,151	532,710	55
1927	215,786	804,006	3.73	122	250,794	466,580	48
1928	312,815	1,081,758	3.46	113	457,123	769,938	79
1929	333,465	1,250,141	3.75	123	514,336	847,801	87
1930	347,512	1,028,680	2.96	97	368,114	715,726	73
1931	330,848	974,820	2.95	97	352,066	682,914	70
1932	189,703	498,570	2.63	86	253,248	442,951	45
1933	284,311	769,942	2.71	89	374,417	658,728	68
1934	432,524	1,216,363	2.81	92	366,315	798,839	82
1935	514,192	1,583,074	3.08	101	397,113	911,305	93
1936	547,236	1,666,194	3.04	100	429,313	976,549	100
1937	584,166	1,777,787	3.04	100	524,430	1,108,596	114
1938	555,629	1,685,766	3.03	99	334,234	889,863	91
1939	519,497	1,560,000	3.08	101	482,336	1,001,833	103
1940	626,640	1,920,000	3.06	100	407,004	1,003,644	103
1941	659,498	2,035,000	3.09	101	368,838	1,028,336	105

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TABLE 4. - Salt

Year	Domestic production				Net exports (-) or imports (+) (short tons)	Apparent consumption	
		Value					
	Short tons	Total	Average per ton	Price index nos. 1935-39, ave. = 100		Short tons	Index nos. 1935-39, ave. = 100
1910	4,242,792	$7,900,344	$1.86	69	+ 88,090	4,330,882	50
1911	4,365,756	8,345,692	1.91	70	+ 93,217	4,458,973	52
1912	4,665,473	9,402,772	2.02	75	+ 77,403	4,742,876	55
1913	4,815,902	10,123,139	2.10	77	+ 84,476	4,900,378	57
1914	4,872,656	10,197,417	2.09	77	+ 48,509	4,921,165	57
1915	5,352,409	11,747,686	2.19	81	+ 41,852	5,394,261	63
1916	6,362,906	13,645,947	2.14	79	+ 38,014	6,400,920	74
1917	6,978,177	19,940,442	2.86	106	- 49,071	6,929,106	80
1918	7,238,744	26,940,361	3.72	137	- 96,493	7,142,251	83
1919	6,882,902	27,074,694	3.93	145	- 58,902	6,824,000	79
1920	6,840,029	29,894,075	4.37	161	- 1,618	6,838,411	79
1921	4,981,154	24,557,966	4.93	182	- 16,648	4,964,686	58
1922	6,792,849	27,464,838	4.04	149	- 23,279	6,769,570	79
1923	7,130,713	27,795,941	3.90	144	- 36,779	7,093,934	82
1924	6,803,115	25,747,048	3.78	140	- 56,007	6,747,108	78
1925	7,397,500	26,162,361	3.54	131	- 69,291	7,328,209	85
1926	7,371,600	25,055,012	3.40	125	- 102,944	7,268,656	84
1927	7,568,690	24,817,962	3.28	121	- 108,864	7,459,826	87
1928	8,074,700	26,772,368	3.32	123	- 102,540	7,972,160	93
1929	8,543,560	27,334,695	3.20	118	- 72,772	8,470,788	98
1930	8,054,440	25,009,480	3.11	115	- 16,457	8,037,983	93
1931	7,358,070	21,541,012	2.93	108	- 65,494	7,292,576	85
1932	6,407,973	19,938,830	3.11	115	- 35,563	6,372,410	74
1933	7,604,972	22,318,086	2.93	108	- 75,046	7,529,926	87
1934	7,612,074	22,850,797	3.00	111	- 52,241	7,559,833	88
1935	7,926,897	21,837,911	2.75	102	- 60,967	7,865,930	91
1936	8,828,936	23,306,177	2.64	97	- 25,884	8,803,052	102
1937	9,241,564	24,131,733	2.61	96	- 24,115	9,217,449	107
1938	8,025,768	23,242,561	2.90	107	- 27,985	7,997,783	93
1939	9,277,911	24,509,680	2.64	97	- 78,240	9,199,671	107
1940	10,359,960	26,474,619	2.56	96	- 116,642	10,243,318	119

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Prices. - The average value per ton of salt was very low before World War I, ranging from $1.86 to $2.19 a ton. It attained an all-time high of $4.93 in 1921. From 1922 to 1934 it ranged from $3 to $4 a ton, but since that year it has fallen as low as $2.61 and has not exceeded $2.90. In 1943, when high war prices prevailed generally, the average unit sales value was lower than the lowest point reached during the depression period.

Chemical and Industrial Lime

Consumption. - Lime, "the king of all the bases," is one of the most important chemical raw materials. Some of the chemical and industrial processes in which lime is involved follow: Causticization, coagulation, distillation, precipitation, neutralization, solution, hydrolysis, dehydration, high-temperature processes, high-pressure processes, gas absorption, saponification, and catalysis. Lime either forms a part of, or enters into the process of manufacture of, a multitude of products, and for most of its uses the substitution of some other material is difficult or impossible. Some of the more important products for which lime is essential are alkalies, asphalts, bleaching compounds, sand-lime and silica brick, calcium carbide and cyanamide, explosives, glass, glue, lubricants, insecticides, leather (tanning), 85 percent magnesia, paints, paper, petroleum (refining), rubber, soap, steel (fluxing), sugar, textiles, and varnish.

Because of its many and varied applications, the use of lime has grown proportionally with the development of industrialization. As indicated in table 5, from 1910 to the beginning of the First World War consumption was less than half as great as during 1935-39, but the industry expanded considerably thereafter to supply war needs. After a brief recession, consumption increased to high levels during the prosperous period before the industrial depression of the early 30's, during which it suffered a set-back. A strong recovery marked 1936 and 1937, followed by a decline in 1938, but since that date growth has been continuous and strong. The immense demands of war industries stimulated a consumption in 1943 two and one-fourth times as great as the 1935-39 average. Lime is a firmly established chemical and industrial product, and the future of the chemical lime industry will undoubtedly follow the trend of industrial activity.

Prices. - Lime prices were less than $4.00 a ton from 1910 to 1914, but thereafter they increased rapidly to more than double that value. They remained at this high level until 1926, when a decline began, and since 1930 the price, f.o.b. mill, has ranged between $6 and $7 a ton. Fluctuations from year to year have been moderate.

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TABLE 5. - Chemical and industrial lime[1/]

Year	Domestic production				Apparent consumption	
		Value				
	Short tons	Total	Average per ton	Price index nos. 1935-39, ave. = 100	Short tons[2/]	Index no 1935-3 ave. =
1910	676,486	$2,701,132	$3.99	58	676,486	27
1911	776,435	3,016,493	3.89	57	776,435	31
1912	808,123	3,078,411	3.81	56	808,123	33
1913	954,797	3,684,483	3.86	57	954,797	39
1914	886,657	3,269,980	3.69	54	886,657	36
1915	1,204,689	4,854,265	4.03	59	1,204,689	49
1916	1,576,927	6,578,560	4.17	61	1,576,927	64
1917	1,790,546	11,372,647	6.35	93	1,790,546	72
1918	1,789,440	15,368,077	8.59	126	1,789,440	72
1919	1,610,164	13,664,287	8.49	124	1,610,164	65
1920	1,841,422	18,381,349	9.98	146	1,841,422	75
1921	960,104	8,824,776	9.19	135	960,104	39
1922	1,466,865	12,210,060	8.32	122	1,466,865	59
1923	1,704,159	15,646,495	9.18	134	1,704,159	69
1924	1,653,964	14,719,974	8.90	130	1,653,964	67
1925	1,894,580	16,364,552	8.64	127	1,894,580	77
1926	1,943,065	16,186,185	8.33	122	1,943,065	79
1927	1,943,199	15,437,783	7.94	116	1,943,199	79
1928	2,138,037	16,455,657	7.70	113	2,138,037	87
1929	2,290,612	16,787,408	7.33	107	2,290,612	93
1930	1,840,155	13,193,437	7.17	105	1,840,155	74
1931	1,463,217	9,810,514	6.70	98	1,463,217	59
1932	1,118,591	7,084,510	6.33	93	1,118,591	45
1933	1,490,082	9,106,818	6.11	89	1,490,082	60
1934	1,663,591	11,425,031	6.87	101	1,663,591	67
1935	2,047,579	14,130,014	6.90	101	2,047,579	83
1936	2,521,211	17,235,586	6.84	100	2,521,211	102
1937	2,769,150	19,139,740	6.91	101	2,769,150	112
1938	2,128,181	14,598,365	6.86	100	2,128,181	86
1939	2,891,515	19,270,843	6.66	98	2,891,515	117
1940	3,511,671	23,329,716	6.64	97	3,511,671	142
1941	4,631,090	31,294,999	6.76	99	4,631,090	187
1942	5,005,483	35,675,283	7.13	104	5,005,483	203
1943	5,584,524	41,075,397	7.36	108	5,584,524	226

1/ Including dead-burned dolomite.

2/ As imports and exports are negligible, consumption is virtually equivale to production.

Chemical Limestone

Consumption. - As indicated, lime is used extensively in many chemical processes. In addition to the lime sold for such uses, large quantities of limestone are sold raw for employment in these same industries. In statist cal compilations of the Bureau of Mines the lime and limestone are consider

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eparately even though they may ultimately be used in the same way in the ame chemical processes. Table 6 shows sales of raw stone to a group of ive important industries - alkali, calcium carbide, glass, paper, and ugar - from 1920 to 1943.

Except for the brief recession in 1921 and 1922, sales of chemical limetone were maintained at levels approximating three-fourths of the 1935-39 verage until 1925 when an upward movement was evident, culminating in a aximum for the predepression period of more than 6,363,000 tons in 1929. his was 111 percent of the 1935-39 average. Following the lower demands f the depression period there was a moderate recovery until 1940, when nder the stimulus of war activities consumption increased greatly.

TABLE 6. - Chemical limestone[1/]

Year	Domestic production				Apparent consumption[2/]	
		Value				
	Short tons	Total	Average per ton	Price index nos. 1935-39, ave. = 100	Short tons	Index nos. 1935-39, ave. = 100
920[3/]	4,443,454	$4,260,961	$0.96	139	4,443,454	78
921...	2,775,810	3,070,825	1.11	161	2,775,810	49
922...	3,437,380	3,187,136	.93	135	3,437,380	60
923...	4,494,320	3,990,308	.89	129	4,494,320	79
924...	4,196,560	3,806,584	.91	132	4,196,560	73
925...	4,764,060	4,098,886	.86	125	4,764,060	83
926...	4,859,600	4,223,578	.87	126	4,859,600	85
927...	5,185,470	4,352,148	.84	122	5,185,470	91
928...	5,437,730	4,348,464	.80	116	5,437,730	95
929...	6,363,680	5,257,396	.83	120	6,363,680	111
930...	5,688,220	4,494,730	.79	114	5,688,220	100
931...	4,311,640	3,563,871	.83	120	4,311,640	75
932...	4,169,230	3,363,341	.81	117	4,169,230	73
933...	5,315,540	3,615,300	.68	99	5,315,540	93
934...	5,022,940	3,519,898	.70	101	5,022,940	88
935...	5,277,800	3,718,215	.70	101	5,277,800	92
936...	5,805,080	3,870,080	.67	97	5,805,080	102
937...	6,496,960	4,474,259	.69	100	6,496,960	114
938...	4,893,980	3,422,227	.70	101	4,893,980	86
939...	6,096,040	4,069,679	.67	97	6,096,040	107
940...	6,524,520	4,326,923	.66	96	6,524,520	114
941...	7,728,820	5,223,100	.68	99	7,728,820	135
942...	8,275,850	5,807,969	.70	101	8,275,850	145
943...	8,631,320	6,897,831	.80	116	8,631,320	151

Includes limestone sold for alkali, carbide, glass, paper, and sugar manufacture.
As imports and exports are negligible, consumption is approximately equivalent to production.
Comparable data before 1920 unavailable.

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Prices. - Prices of limestone in the 1920's were generally higher than in the period following 1932. In 1943, however, under the stress of war, the price was as high as in several earlier years. The lower level of unit values that has prevailed generally during the past decade is due primarily to increasing mechanization and growing efficiency in quarrying and crushing operations. The 1935-39 average was 69 cents a ton at the shipping point.

Metallurgical Limestone (Flux)

Consumption. - The process of recovering metallic iron from its ores generally requires the addition of large quantities of limestone, which combines in the blast furnace with the silica and alumina impurities of the ore and carries them off in the form of a basic slag. Other metallurgical industries require smaller quantities. The production of fluxing stone has been a large industry for many years; in fact, the output of 1910 as indicated in table 7 exceeded 20 million short tons. The enormous demand for iron and steel during the World War of 1914-18 led to an output of fluxing stone in 1917 exceeding 28 million tons. Except for the decisive drop in 1921, sales were maintained at high levels until the great industrial depression at the depth of which consumption was only 25 percent of the 1935-39 average. The slow recovery from the inertia of that period is evidenced by the fact that the 1935-39 average (15,638,296 short tons) was little more than three-fourths of the output of 1910. However, the unprecedented requirements of iron and steel for war equipment, both for the United States and its allies, have increased the needs for fluxing stone very greatly since 1939. The 1943 consumption was more than twice as great as the 1935-39 average.

Prices. - From 1910 to 1915 prices of fluxing limestone were very low, averaging less than 50 cents a ton or about two-thirds of the 1935-39 average. Thereafter they increased considerably, ranging generally from 80 cents to more than $1.00 a ton until 1925. From 1925 to 1932 prevailing prices, averaged for the entire country, ranged from 72 to 76 cents a ton and from 1933 to 1940 averaged 69 cents. Owing to war stimulus, prices from 1941 to 1943 were somewhat higher. Unit values have fluctuated within a comparatively narrow range since 1921.

Fluorspar

Consumption. - The principal use of fluorspar is as a flux in open-hearth steel manufacture. The second largest application is for making hydrofluoric acid essential to aluminum metallurgy and having other important uses. The glass and enamel trades are next in importance as users, and smaller quantities are employed in many diverse products. No satisfactory substitutes have been found for fluorspar for most of its uses. Demands have always exceeded domestic supply; therefore there has been a substantial dependence upon foreign sources.

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TABLE 7. - Metallurgical limestone (flux)

Year	Domestic production				Apparent consumption[1]	
		Value				
	Short tons	Total	Average per ton	Price index nos. 1935-39, ave. = 100	Short tons	Index nos. 1935-39, ave. = 100
910	20,388,348	$9,345,733	$0.46	67	20,388,348	130
911	18,061,848	7,987,208	.44	64	18,061,848	115
912	22,613,420	9,937,772	.44	64	22,613,420	145
913	25,335,476	11,103,989	.44	64	25,335,476	162
914	17,134,607	7,890,369	.46	67	17,134,607	110
915	21,278,570	9,672,347	.45	65	21,278,570	136
916	26,435,929	13,936,882	.53	77	26,435,929	169
917	28,640,044	18,679,213	.65	94	28,640,044	183
918	26,725,472	23,427,736	.88	128	26,725,472	171
919	21,200,350	19,271,674	.91	132	21,200,350	136
920	24,977,190	26,475,763	1.06	154	24,977,190	160
921	10,644,290	9,428,767	.86	125	10,644,290	68
922	18,690,270	14,208,457	.76	110	18,690,270	120
923	25,562,140	20,333,939	.80	116	25,562,140	163
924	19,683,150	15,827,464	.80	116	19,683,150	126
925	22,840,500	17,318,366	.76	110	22,840,500	146
926	23,849,700	18,021,449	.76	110	23,849,700	153
927	21,660,820	15,977,484	.74	107	21,660,820	139
928	23,094,090	16,929,986	.73	106	23,094,090	148
929	24,337,280	17,994,110	.74	107	24,337,280	156
930	17,021,350	12,312,602	.72	104	17,021,350	109
931	9,674,800	7,160,630	.74	107	9,674,800	62
932	3,945,170	2,902,847	.74	107	3,945,170	25
933	7,982,560	5,510,445	.69	100	7,982,560	51
934	9,230,880	6,297,579	.68	99	9,230,880	59
935	12,191,660	7,902,717	.65	94	12,191,660	78
936	17,724,880	11,576,156	.65	94	17,724,880	113
937	21,311,250	14,685,215	.69	100	21,311,250	136
938	9,692,130	6,933,621	.72	104	9,692,130	62
939	17,271,560	12,618,938	.73	106	17,271,560	110
940	22,856,910	15,738,887	.69	100	22,856,910	146
941	27,432,520	20,064,159	.73	106	27,432,520	175
942	30,259,250	24,147,313	.80	116	30,259,250	193
943	31,570,650	24,505,567	.78	113	31,570,650	202

[1] As imports and exports are negligible, consumption is approximately equivalent to production.

Steel and aluminum are classed with the capital goods industries that re quite sensitive to booms and depressions, and as the fluorspar industry epends for its prosperity primarily upon them, it is also in the "prince or uper" class. As indicated by the index numbers of apparent consumption own in table 8, violent fluctuations have marked the course of the industry nce 1910. Peak consumption of the earlier period was in 1918 under the timulus of World War I. The demand was only half as great during the

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following year, and by 1921 it was little more than one-eighth of the warti maximum. The industry operated at relatively high levels during the prosp ous era from 1922 to 1930 but suffered severely during the depression years It made an astonishing recovery in 1936 and 1937 but slumped badly in 1938. The unprecedented demands of metallurgy during World War II stimulated con- sumption of fluorspar far beyond all previous records. A fluctuating fut history is anticipated unless circumstances can be so modified that the metallurgical industries may follow a more steady and uniform course.

Prices. - Prices have fluctuated much less than the quantities consum From the low level of the 1910 to 1916 period, during which they remained about one-third of the 1935-39 average, they increased suddenly to an all- time high during the inflationary period of 1919 and 1920. Thereafter the fell within a range of not more than 10 percent above or below the 1935-39 average except in the depression period, when they dropped to 15 or 20 per cent below that level. Even under the stimulus of the unusually heavy dem created by the needs of the Second World War, prices in 1941 were only 17 cent greater than the 1935-39 average. Prices subsequent to 1941 were uni Government control but were purposely raised to considerably higher levels stimulate production.

Barite

Consumption. - Barite has a variety of uses, depending upon its chemi and physical properties. Its barium content makes it useful in the barium chemical and glass industries, a good white color is an asset in its emplo ment in the paint, lithopone, and paper industries, and its high specific gravity gives it value as an oil-well drilling mud. For many years litho- pone manufacture was the largest use, but since 1938 its application to th manufacture of drilling muds has become of equal or greater importance.

Consumption from 1910 to 1914 was 17 to 23 percent of the average qu used during the 1935-39 period. From 1916 to 1926 consumption was three four times as great as during the earlier period, except for the decline pre-World War I levels in 1921. During the next 10 years, consumption ad vanced still further, but in only one year - 1929 - did it equal or excee the 1935-39 average. Since 1937 consumption has increased greatly, due primarily to the growing use of barite in oil-well drilling. Consumption in 1941 was more than eight times as high as in 1910.

Prices. - Prices of crude barite f.o.b. mine, as indicated in table ranged from one-half to two-thirds of the 1935-39 average from 1910 to 19 and thereafter they increased rapidly. From 1918 to 1930 they ranged fro 107 to 155 percent of that average. They declined considerably during th depression and advanced thereafter but remained at levels somewhat below average of the 13 years (1918 to 1930) immediately preceding the depressi period. The war had no apparent effect on average prices from 1939 to 19

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Year	Domestic production				Net imports (+) or exports (-) (short tons)	Apparent consumption	
	Short tons	Value				Short tons	Index nos. 1935-39, ave. = 100
		Total	Average per ton	Price index nos. 1935-39, ave. = 100			
1910	69,427	$430,196	$6.20	33	+ 42,488	111,915	65
1911	87,048	611,447	7.02	38	+ 32,764	119,812	70
1912	116,545	769,163	6.60	35	+ 26,176	142,721	83
1913	115,580	736,286	6.37	34	+ 22,682	138,262	81
1914	95,116	570,041	5.99	32	+ 10,205	105,321	62
1915	136,941	764,475	5.58	30	+ 7,167	144,108	84
1916	155,735	922,654	5.92	32	+ 12,323	168,058	98
1917	218,828	2,287,722	10.45	56	+ 13,616	232,444	136
1918	263,817	5,465,481	20.72	111	+ 12,572	276,389	162
1919	138,290	3,525,574	25.49	137	+ 6,943	145,233	85
1920	186,778	4,718,547	25.26	136	+ 21,848	208,626	122
1921	34,960	724,094	20.71	111	+ 6,229	41,189	24
1922	141,596	2,531,165	17.88	96	+ 30,812	172,408	101
1923	121,188	2,505,819	20.68	111	+ 41,082	162,270	95
1924	124,979	2,451,131	19.61	105	+ 50,426	175,405	103
1925	113,669	2,052,342	18.06	97	+ 47,645	161,314	94
1926	128,657	2,341,277	18.20	98	+ 73,539	202,196	118
1927	112,546	2,034,728	18.08	97	+ 71,130	183,676	107
1928	140,490	2,656,554	18.91	102	+ 46,785	187,275	110
1929	146,439	2,791,126	19.06	102	+ 53,839	200,278	117
1930	95,849	1,746,643	18.22	98	+ 64,622	160,471	94
1931	53,484	931,275	17.41	94	+ 20,398	73,882	43
1932	25,251	392,499	15.54	83	+ 13,211	38,462	22
1933	72,930	1,039,178	15.25	82	+ 10,337	83,267	49
1934	85,786	1,391,405	16.22	87	+ 16,183	101,969	60
1935	123,741	1,860,638	15.04	81	+ 16,027	139,768	82
1936	176,877	3,119,668	17.64	95	+ 25,264	202,141	118
1937	181,230	3,666,629	20.23	109	+ 36,607	217,837	127
1938	80,403	1,599,666	19.90	107	+ 18,834	99,237	59
1939	182,771	3,704,959	20.27	109	+ 13,326	196,097	115
1940	233,600	4,744,803	20.31	109	+ 3,389	236,989	139
1941	320,669	6,724,782	20.97	113	- 4,660	316,009	185
1942	360,316	8,897,749	24.69	133	- 6,865	353,451	207

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TABLE 9. - Barite

Year	Domestic production				Net imports (short tons)	Apparent consumption	
		Value					
	Short tons	Total	Average per ton	Price index nos. 1935-39, ave. = 100		Short tons	Index nos. 1935-39, ave. = 100
1910	42,975	$121,746	$2.83	47	21,270	64,245	18
1911	38,445	122,792	3.19	53	20,214	58,659	17
1912	37,478	153,313	4.09	67	26,186	63,664	18
1913	45,298	156,275	3.45	57	35,840	81,138	23
1914	52,747	155,647	2.95	49	24,423	77,170	22
1915	108,547	381,032	3.51	58	2,504	111,051	32
1916	221,952	1,011,232	4.56	75	17	221,969	64
1917	206,888	1,171,184	5.66	93	6	206,894	59
1918	155,368	1,044,905	6.73	111	-	155,368	45
1919	209,330	1,727,822	8.25	136	118	209,448	60
1920	228,113	2,142,464	9.39	155	24,874	252,987	73
1921	66,369	531,958	8.02	132	11,054	77,423	22
1922	155,040	1,123,950	7.25	119	23,239	178,279	51
1923	214,183	1,664,156	7.77	128	15,045	229,228	66
1924	196,332	1,540,744	7.85	129	21,502	217,834	63
1925	228,063	1,703,097	7.47	123	28,655	256,718	74
1926	237,875	1,773,293	7.45	123	51,016	288,291	83
1927	254,265	1,670,878	6.57	108	70,274	324,539	93
1928	269,544	1,754,924	6.51	107	61,765	331,309	95
1929	277,269	1,850,706	6.67	110	85,729	362,998	104
1930	234,932	1,538,171	6.55	108	52,111	287,043	82
1931	174,520	994,655	5.70	94	73,080	247,600	71
1932	129,854	745,955	5.74	95	45,758	175,612	50
1933	167,880	852,611	5.08	84	49,958	217,838	63
1934	209,850	1,109,378	5.29	87	40,031	249,881	72
1935	225,111	1,251,268	5.56	92	47,048	272,159	78
1936	283,160	1,674,631	5.91	97	33,843	317,003	91
1937	355,888	2,240,970	6.30	103	64,992	420,880	121
1938	309,663	2,004,521	6.47	107	24,845	334,508	96
1939	383,609	2,344,103	6.11	101	11,588	395,197	114

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Boron Minerals

Consumption. - The principal use of boron minerals is as a constituent of at-resisting container glass, also optical and other special scientific assware. They are used also in vitreous enamel, in metallurgy, to an increasing extent in fertilizers, and in a wide variety of minor applications. e United States occupies an unusually favorable position with respect to ron minerals in that it produces more than 90 percent of world supplies.

From a consumption in 1910 of about one-fourth of the 1935-39 average e use of boron minerals increased more than threefold during the next 25 ars. This large increase was due primarily to enlarged employment in amelware and particularly in heat-resistant glass. The pronounced increase use during the war is to be attributed to the substitution of glass and her ceramic products for metals and alloys that were restricted to military eds. Consumption in 1941 was nearly six times as great as in 1910.

Prices. - Although price levels fluctuated greatly from year to year, e average value per ton in 1941 was approximately the same as in 1910. Beuse of improved methods of recovery and preparation prices have generally en considerably lower since 1931 than in previous years, the upward trend 1940 and 1941 being due primarily to war inflation.

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TABLE 10. - Boron minerals

Year	Domestic production				Net imports(+) or exports (-)	Apparent consumption	
		Value					
	Short tons	Total	Average per ton	Price index nos. 1935-39, ave. = 100		Short tons	Index nos. 1935-39, ave. = 100
1910	42,357	1,201,842	$28.37	136	+ 3	42,360	24
1911	53,330	1,569,151	29.42	141	+ 5	53,335	31
1912	42,315	1,127,813	26.65	127	+ 5	42,320	24
1913	58,051	1,491,530	25.69	123	+ 2	58,053	33
1914	62,400	1,464,400	23.47	112	+ (1)	62,400	36
1915	67,003	1,677,099	25.03	120	-	67,003	39
1916	103,585	2,409,459	23.27	111	+ (1)	103,525	60
1917	108,875	3,609,632	33.15	158	-	108,875	63
1918	88,794	2,263,230	25.49	122	+ 5	88,799	51
1919	66,146	1,380,000	20.86	100	+ 1	66,147	38
1920	120,320	2,173,000	18.06	86	- 7,160	113,160	65
1921	50,000	1,600,000	32.00	153	+ 1,889	51,889	30
1922	85,220	2,705,140	31.74	152	- 5,097	80,123	46
1923	136,650	3,994,790	29.23	140	- 10,817	136,650	79
1924	116,110	3,183,910	27.42	131	- 12,511	125,833	73
1925	113,700	3,085,660	27.14	130	- 11,344	102,356	59
1926	115,970	3,128,110	26.97	129	- 9,709	106,261	61
1927	109,080	3,473,399	31.84	152	- 29,114	79,966	46
1928	131,000	3,999,773	30.53	146	- 62,811	68,189	39
1929	169,870	4,515,375	26.58	127	- 74,794	95,076	55
1930	177,360	5,351,999	30.18	144	- 82,931	94,429	54
1931	178,550	4,931,295	27.62	132	- 86,368	92,182	53
1932	181,915	3,023,844	16.62	79	- 89,641	92,274	53
1933	188,047	3,436,377	18.27	87	- 86,608	101,439	58
1934	242,400	4,822,014	19.89	95	- 103,643	138,757	80
1935	272,967	5,381,560	19.72	94	- 114,447	158,520	91
1936	313,759	6,156,123	19.62	94	- 102,020	211,739	122
1937	358,898	7,232,897	20.15	96	- 154,052	204,846	118
1938	215,662	4,739,290	21.98	105	- 77,519	138,143	80
1939	245,284	5,669,797	23.20	111	- 91,139	154,145	89
1940	243,355	5,403,300	23.19	111	- 64,313	179,042	103

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Potash

Consumption. - Potash, an essential fertilizer material, is the subject ? one of the most dramatic chapters in the history of American mining. Domes- ic production before 1915 was negligible, and the United States depended upon reign countries, chiefly Germany, for virtually its entire needs. From 1910 til the United States was drawn into the First World War consumption as indi- ted in table 11, was 48 to 65 percent of the 1935-39 average, but when the r stopped all imports it was found impossible to produce more than a mere action of domestic needs. Consumers frantically sought supplies from such ager sources as kelp, cement-plant dust, refinery waste at sugar mills, wool shings, and wood ashes to supplement the small tonnages obtained from natural lts or brines. In 1916 consumption was only 4 percent of the 1935-39 average d had reached only 20 percent by 1920. When potash again became available om foreign sources domestic production declined and remained at a low level til 1927, when it increased considerably due chiefly to more extensive utili- tion of the California lake brines.

The discovery of large deposits of soluble potash salts at Carlsbad, N. Mex., om which commercial production was first obtained in 1931, brought about a dical change in the situation. Mines were sunk and refineries built, and adually the potash salts of this region - supplemented by salts obtained om saline lakes in California and Utah - became sufficient to supply our tire needs. Imports, however, remained at a high level until the beginning the Second World War, when supplies from Germany, and later from France, ain became unavailable. The domestic industry had by this time attained bstantial growth. In 1935, for the first time since 1919, production ex- eded net imports. In 1941, for the first time in the history of the industry, ports exceeded imports.

War demands for both food and chemicals stimulated a heavy demand for tash since 1939, and production increased strikingly. The 1941 output from mestic sources was nearly five times as great as in 1934. Consumption since 41 cannot be revealed at this time because foreign trade figures are con- dential, but domestic sales which furnished more than enough for the Nation's eds exceeded 732,000 tons in 1943. The national situation with respect to tash is immeasurably better during the present war than in 1914-18, and there definite prospect that the United States will be self-sufficient in this portant commodity for many years.

Prices. - Due to the extreme scarcity of potash from 1915 to 1918, prices re fantastically high. In 1916 the price of $436.49 a ton was more than 14 mes the 1935-39 average. Even when imports were again available following armistice of 1918 prices remained fairly high until 1932, when material m the Carlsbad (N. Mex.) mines began to enter the market in quantity, but e price decline was due in part to shrinking markets resulting from the de- ession. Prices were exceptionally low in 1934 and 1935, but since that time ey have remained between $31 and $34 per ton of K_2O content.

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TABLE 11. - Potash (K_2O)

Year	Domestic production				Net imports (+) or exports (-)	Apparent consumption	
	Short tons	Value				Short tons	Index nos. 1935-39, ave. = 100
		Total	Average per ton	Price index nos. 1935-39, ave. = 100			
1910	(1)	(1)	(1)	-	+ 279,780	279,780	65
1911	(1)	(1)	(1)	-	+ 274,446	274,446	63
1912	(1)	(1)	(1)	-	+ 253,678	253,678	59
1913	(1)	(1)	(1)	-	+ 272,457	272,457	63
1914	(1)	(1)	(1)	-	+ 207,089	207,089	48
1915	1,090	$342,000	$313.76	1,018	2/ + 48,867	49,957	12
1916	9,720	4,242,730	436.49	1,415	2/ + 7,885	17,605	4
1917	32,573	13,980,577	429.21	1,392	2/ + 8,100	40,673	9
1918	38,580	15,839,618	410.57	1,322	2/ + 7,957	46,537	11
1919	45,728	11,271,269	246.49	800	2/ + 39,619	85,347	20
1920	41,444	7,463,026	180.07	584	2/ + 224,792	266,236	62
1921	4,408	447,859	101.60	328	2/ + 78,698	83,106	19
1922	11,313	463,512	40.97	133	2/ + 201,415	212,728	49
1923	19,281	784,671	40.70	132	2/ + 209,950	229,231	53
1924	21,880	842,612	38.51	125	2/ + 200,365	222,245	51
1925	25,802	1,204,024	46.66	151	2/ + 258,217	284,019	66
1926	25,060	1,083,064	43.22	140	2/ + 266,280	291,340	67
1927	49,500	2,448,146	49.46	160	2/ + 244,155	293,655	68
1928	60,370	3,029,422	50.18	163	2/ + 330,493	390,863	91
1929	57,540	2,988,448	51.94	168	3/ + 314,786	372,326	86
1930	56,610	2,986,157	52.75	171	3/ + 331,789	388,399	90
1931	63,770	3,086,955	48.41	145	3/ + 194,904	258,774	60
1932	55,620	2,102,590	37.80	123	3/ + 111,975	167,595	39
1933	139,067	5,296,793	38.09	124	3/ + 154,556	293,623	68
1934	114,122	2,813,218	24.65	80	3/ + 154,420	268,542	62
1935	224,721	4,993,481	22.22	72	3/ + 194,646	419,369	97
1936	222,810	6,969,190	31.28	101	3/ + 149,116	371,926	86
1937	266,938	9,019,534	33.79	110	3/ + 288,893	555,831	129
1938	286,437	9,748,290	34.03	110	3/ + 142,211	428,648	99
1939	366,287	12,028,195	32.84	107	3/ + 16,826	383,113	89
1940	393,058	12,562,050	31.96	104	3/ + 57,891	450,949	104
1941	521,346	17,368,257	33.69	106	3/ - [illegible],861	487,485	113

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Phosphate Rock

Consumption. - The United States has enormous reserves of phosphate rock
it will be adequate for domestic needs and for a substantial export trade
many years. Phosphate-rock consumption (see table 12) from 1910 to 1916
ged from 60 to 70 percent of the 1935-39 average but was considerably
her from 1917 to 1921. The low level of demand during the early years
the First World War was probably due to the diversion of sulfuric acid
m fertilizer manufacture to the production of munitions. Following a
rt post-war recession, consumption increased to a level of 80 to more
n 100 percent of the 1935-39 average until the depression period, during
ch it declined greatly. Since 1936 the demands of agriculture have stimu-
ed a growing market. The strong movement to increase food supplies to
isfy the demands of the armed forces, the civilian population, and our
ies and to assist liberated countries led to a consumption in 1941 nearly
percent greater than the 1935-39 average. Continued heavy demands are
icipated until such time as the food situation throughout the world has
roved.

Prices. - Phosphate-rock prices have followed an unusual pattern. From
.0 to 1914 they were considerably higher than during recent years, but
ing the First World War they stood at lower levels than in any year from
.0 to 1931. After the brief inflationary period of 1920-21, when they were
highest in history, they dropped to the approximate level of the 1935-39
rage, and only moderate variations have been noted during subsequent years.
slight down trend was in evidence from 1938 to 1941.

Nitrogen

Consumption. - Nitrogen is an essential plant food. Unlike potash and
sphate, the supply of which must be replenished chiefly from outside sources,
arge part - roughly two-thirds of the nitrogen utilized by crops - is ob-
ned by biochemical fixation through micro-organisms. It is important,
vever, that the deficiency be met from outside sources if nitrogen starva-
n is to be avoided.

Nitrogen was for many years supplied primarily from the famous nitrate
osits of Chile, but since the late 1920's synthetic nitrogen derived from
atmosphere has constituted an important part of our domestic supplies.
sumption of nitrogen for fertilizer uses has increased tremendously since
0. Table 13 shows consumption in various years from that date until 1942.
includes both chemical and natural organic nitrogen, and the territory
ered is the continental United States, Hawaii, and Puerto Rico.

Before the beginning of the twentieth century the nitrogen requirements
the soil were relatively small, but as the natural supplies were depleted
repeated cropping the demands increased rapidly. Demands in 1910 were more
n twice as great as in 1900 and in 1920 were nearly 60 percent higher than
1910. The next 10 years marked a further large advance; but during follow-
years, except for the moderate decline of the depression period, consump-
n has not fluctuated greatly from the high level of 1930, except for the
k year 1941 when consumption exceeded 450,000 tons.

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TABLE 12. - Phosphate rock

Year	Domestic production				Net exports (long tons)	Apparent consumption	
		Value					
	Long tons	Total	Average per ton	Price index nos. 1935-39, ave. = 100		Long tons	Index nos. 1935-39, ave. = 100
1910	2,654,988	$10,917,000	$4.11	121	1,083,037	1,571,951	63
1911	3,053,279	11,900,693	3.90	115	1,246,577	1,806,702	73
1912	2,973,332	11,675,774	3.93	116	1,206,520	1,766,812	71
1913	3,111,221	11,796,231	3.79	111	1,366,508	1,744,713	70
1914	2,734,043	9,608,041	3.51	103	964,114	1,769,929	71
1915	1,835,667	5,413,449	2.95	87	253,421	1,582,246	64
1916	1,982,385	5,896,993	2.97	87	239,066	1,743,319	70
1917	2,584,287	7,771,084	3.01	89	166,266	2,418,021	97
1918	2,490,760	8,214,463	3.30	97	143,455	2,347,305	95
1919	2,271,983	11,591,268	5.10	150	378,697	1,893,286	76
1920	4,103,982	25,079,572	6.11	180	1,069,649	3,034,333	122
1921	2,064,025	12,270,070	5.94	175	729,777	1,334,248	53
1922	2,417,833	10,482,846	4.34	128	713,404	1,704,479	69
1923	3,006,706	11,576,049	3.85	113	820,826	2,185,880	88
1924	2,867,789	10,252,083	3.57	105	802,675	2,065,114	83
1925	3,481,819	11,545,678	3.32	98	867,465	2,614,354	105
1926	3,209,976	10,893,800	3.39	100	731,585	2,478,391	100
1927	3,170,699	11,253,352	3.55	105	890,016	2,280,683	92
1928	3,501,406	12,443,179	3.55	105	852,952	2,648,454	107
1929	3,760,855	13,153,259	3.50	103	1,097,847	2,663,008	107
1930	3,926,392	13,996,830	3.56	105	1,193,064	2,733,328	110
1931	2,534,959	9,288,485	3.66	108	937,809	1,597,150	64
1932	1,706,904	5,738,493	3.36	99	600,053	1,106,851	45
1933	2,490,312	7,872,302	3.16	93	821,334	1,668,978	67
1934	2,834,523	10,040,005	3.54	104	993,493	1,841,030	74
1935	3,042,381	10,951,723	3.59	106	1,104,294	1,938,087	78
1936	3,351,857	11,406,132	3.40	100	1,208,951	2,142,906	86
1937	3,956,189	12,975,268	3.28	96	1,039,402	2,916,787	117
1938	3,739,238	12,952,143	3.46	102	1,133,837	2,605,401	105
1939	3,757,067	12,294,048	3.27	96	945,506	2,811,561	113

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TABLE 13. - Consumption of nitrogen as fertilizer in the United States by decades 1880 to 1930, and by years, 1930-42, as compiled by Mehring[1/]

Year	Nitrogen, short tons	Year	Nitrogen short tons
1880	18,817	1934	275,355
1890	45,026	1935	306,058
1900	71,775	1936	350,696
1910	145,379	1937	411,457
1920	227,773	1938	383,794
1930	375,795	1939	390,034
1931	302,422	1940	413,116
1932	218,944	1941	456,162
1933	248,831	1942	2/399,000

1/ Mehring, A. L., Consumption of Commercial Nitrogen as Fertilizer in 1941: Fertilizer Review, vol. 17, No. 3, 1942, p. 3.
2/ Personal communication.

The extensive use of nitrogen in agriculture that has characterized the years since 1929 is due largely to the increasing plant capacity for producing synthetic nitrogen. The United States is, in fact, approaching self-sufficiency in regard to chemical nitrogen. Domestic production in 1914 was only 24 percent of domestic requirements; in recent years it has increased to 70 percent.

Prices. - Nitrogen is sold for agricultural use, principally as ammonium sulfate and sodium nitrate. Prices for certain years before 1925 and for 1925 to 1943 are indicated in table 14. Prices were comparatively high during the First World War and for some years thereafter, but since 1929 they have been much lower. Improvements in processes, general increase in efficiency, and larger-scale operations in synthetic nitrogen plants evidently account for the striking downward trend in prices.

TABLE 14. - Prices of ammonium sulfate and sodium nitrate per unit (20 pounds of nitrogen) 1910, 1915, 1920, and 1925-43[1/]

Year	Ammonium sulfate	Sodium nitrate	Year	Ammonium sulfate	Sodium nitrate
1910	$2.64	$2.76	1933	$1.12	$1.53
1915	3.09	3.04	1934	1.18	1.54
1920	4.08	4.44	1935	1.13	1.47
1925	2.65	3.28	1936	1.23	1.53
1926	2.52	3.27	1937	1.32	1.63
1927	2.33	3.22	1938	1.38	1.69
1928	2.27	2.88	1939	1.35	1.69
1929	2.01	2.78	1940	1.36	1.69
1930	1.79	2.49	1941	1.41	1.69
1931	1.34	2.36	1942	1.41	1.74
1932	1.02	1.86	1943	1.44	1.75

1/ Data 1910-35, from Chemical Nitrogen, U. S. Tariff Com. Rept. 114, 1937, p. 240; 1936-42, from 1943 Year Book, published by Commercial Fertilizer, Atlanta, Ga., p. 52; 1943, personal communication.

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Agricultural Liming Materials

Consumption. - Both burned lime and limestone are employed to supply calcium and magnesium to the soil. Lime has the advantages of quick availability and a higher percentage of the desired active elements calcium and magnesium. Thus the cost of transporting and handling inactive ingredients is at a minimum. Limestone has the advantage of much lower cost, inasmuch as a relatively low cost grinding process is substituted for the more costl calcining of lime. Limestone, however, contains much inactive material, ar its available lime content is only about 47 percent, whereas quicklime contains about 85 percent available lime; moreover, limestone is less readily available in the soil, although its activity may be accelerated by fine grinding. Sales of lime and limestone for agriculture from 1910 to 1943 are shown in table 15. As imports and exports of lime and limestone are negligible, consumption may be regarded as equivalent to domestic sales.

Many years ago lime was used on the soil much more extensively than li stone. The all-time high for lime was in 1914, when more than 684,000 tons were used, but already limestone was gaining rapidly; and in 1915, for the first time, the tonnage of agricultural limestone exceeded that of lime. Thereafter sales of lime declined and remained below 400,000 tons a year from 1920 until 1942, except in 1937, when they advanced to about 420,000 tons. Prosperity, wars, and depressions have not caused more than moderate fluctuations in sales of agricultural lime. During the prosperous years of the late 1920's sales remained around 350,000 tons annually, at the depth of the depression they were not less than 230,000 tons, and the tremendous stimulus of World War II increased them only to 454,000 tons in 1943. However, the war and essential civilian demands for chemical lime in that year no doubt reduced the available supply of agricultural lime.

Lime was used on the soil for many years before uncalcined limestone was so employed. It was reported in 1913[7] that ground limestone had been applied to agricultural uses for only 3 or 4 years. The earliest statistics of agricultural limestone covering 1911 show sales of only 174,290 tons. From the small beginning the industry experienced rapid growth. Production exceeded 2-1/2 million tons in the late 1920's. During the depression years, sales fell to a point lower than that reached in 1916, but since the depression their growth has been phenomenal. In 1937 they exceeded 5 million tons and by 1943 had attained 14-1/2 million tons. The tremendous growth since 19- may be attributed in large measure to the unusually high purchasing power of farmers and to the stimulus afforded by the Agricultural Adjustment Administration, the War Food Administration and Government financing.

7/ Burchard, E. F., Mineral Resources of the United States, 1913, part II Geol. Survey, 1914, p. 1328.

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TABLE 15. - Lime and limestone used for agriculture, 1910-43, in short tons

Year	Lime	Limestone	Year	Lime	Limestone
1910	585,876	(1)	1927	344,974	2,206,470
1911	596,664	174,290	1928	349,281	2,186,870
1912	604,607	200,000	1929	352,329	2,654,580
1913	590,229	408,627	1930	358,111	2,542,100
1914	684,348	615,197	1931	309,519	1,421,050
1915	673,260	810,399	1932	255,200	909,470
1916	613,527	1,066,376	1933	249,424	994,540
1917	488,297	1,040,243	1934	231,104	1,612,380
1918	391,047	1,091,918	1935	298,918	2,140,370
1919	472,883	1,392,914	1936	346,707	3,907,710
1920	390,357	1,364,260	1937	419,560	5,004,930
1921	309,037	1,311,520	1938	379,101	4,367,410
1922	304,165	1,195,000	1939	374,924	5,459,260
1923	259,371	1,278,770	1940	394,094	8,724,160
1924	288,603	1,352,600	1941	382,727	11,909,640
1925	311,523	1,954,480	1942	400,631	13,745,400
1926	308,994	1,850,620	1943	454,133	14,521,670

1/ Data not available.

Table 16 has been compiled to present a reasonably accurate measure of the growth in use of liming materials in agriculture based on the effective lime content of all the materials so used. There was a steady growth from 1910 to 1917, when the effects of World War I, and the moderate depression for 6 years following, restricted the market to some extent, except in 1919 when, for the first time, the effective lime content of total liming materials used exceeded 1 million tons. During the prosperous years from 1925 to 1930, sales ranged from 1 million to nearly 1-1/2 million tons but dropped considerably during the depression years that followed. A striking increase in the use of ground limestone began in 1936, and thereafter total liming materials consumed increased greatly attaining an all-time high of nearly 7,300,000 tons in 1943, a quantity nearly 15 times as great as that used in 1910.

Prices. - The average unit values by years of the principal liming materials are indicated in table 17. The average value of quicklime sold for agriculture (separate figures for which are available only since 1919) has fluctuated within relatively narrow limits. Following the high prices for a period after the First World War (1919-22) the average value of quicklime sold for agriculture ranged generally between $5 and $6 a ton, the unit value in 1923 being virtually identical with that in 1943. The principal exceptions were the lower values of the depression years 1932 and 1933.

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TABLE 16. - Effective lime content of total liming materials sold in the United States, 1910-43

Year	Tons	Year	Tons
1910	520,009	1927	1,231,230
1911	564,629	1928	1,228,000
1912	578,111	1929	1,409,800
1913	652,857	1930	1,364,100
1914	821,728	1931	842,400
1915	892,045	1932	580,400
1916	972,991	1933	632,700
1917	864,357	1934	884,460
1918	814,978	1935	1,196,960
1919	1,009,100	1936	1,918,500
1920	936,000	1937	2,519,700
1921	829,300	1938	2,199,100
1922	777,350	1939	2,632,000
1923	791,970	1940	4,459,540
1924	837,200	1941	6,021,700
1925	1,108,100	1942	6,901,400
1926	1,052,300	1943	7,291,270

Note 1. - Quantities of hydrated lime used in agriculture before 1916 not recorded. They were estimated on basis of 27 percent total hydrated lime, which was the average percentage of hydrated lime sold for agricultur during the years 1916-18.

Note 2. - Effective lime content for 1939 and preceding years calculated on the following basis: Quicklime and oystershell lime, 84 percent; hydrated lime, 70 percent; limestone and calcareous marl, 43 percent. For 1940-43 calculations were made on the following basis: Quicklime and oyste shell lime, 85 percent; hydrated lime, 70 percent; limestone, 47 percent; calcareous marl, 42 percent.

Prices of hydrated lime were low prior to 1917. The average value per ton of hydrated lime used in agriculture exceeded $6 a ton for the first time in 1917, and exceeded $10 a ton in the inflationary period of 1920. From 1921 to 1926 prices were approximately $8 to $9 a ton, and thereafter they fluctuated moderately at levels ranging in general from $6.50 to $7.5 a ton.

Except for the abnormally high prices of 1920 to 1923 and 1926 the un values of pulverized limestone used on the land have fluctuated only moder ately, and have remained generally within the range of $1.10 to $1.50 a to These are bulk prices at point of shipment without containers.

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TABLE 17. - Value per ton of agricultural lime and limestone, 1910-43

Year	Quicklime	Hydrated lime	Limestone	Year	Quicklime	Hydrated lime	Limestone
1910	(1)	(1)	(1)	1927	$5.71	$7.54	$1.52
1911	2/ $2.87	(1)	$1.18	1928	5.79	7.38	1.44
1912	2/ 3.06	(1)	1.56	1929	5.00	7.80	1.42
1913	2/ 3.05	(1)	1.21	1930	5.60	7.39	1.30
1914	2/ 3.13	(1)	1.12	1931	5.38	6.86	1.49
1915	2/ 3.21	(1)	1.10	1932	4.78	5.92	1.35
1916	2/ 3.63	$4.70	1.06	1933	3.74	6.20	1.25
1917	2/ 5.07	6.27	1.30	1934	5.03	7.25	1.11
1918	2/ 6.90	7.99	1.49	1935	5.47	7.27	1.24
1919	6.49	9.00	1.73	1936	5.10	6.87	1.15
1920	7.74	10.24	2.00	1937	5.43	7.43	1.29
1921	6.62	9.10	1.80	1938	5.27	7.19	1.29
1922	6.13	8.34	1.80	1939	5.03	6.88	1.21
1923	5.95	8.95	1.69	1940	4.84	6.44	1.14
1924	5.87	9.04	1.51	1941	5.38	6.86	1.21
1925	5.64	8.29	1.47	1942	5.15	7.26	1.24
1926	6.10	7.95	1.65	1943	5.94	7.56	1.31

(1) Data not available.
2/ Average value total agricultural lime.

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